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SUBJECT: HOW FAST IS BANGKOK SINKING?

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11. SUMMARY AND COMMENT: With a decades-long history of land subsidence similar to that of New Orleans, rising sea levels now threaten the 12 million people of Bangkok with inundation by 2050. ESTHoff and Embassy Science Fellow met with various academic and government actors over several weeks to discuss climate change adaptation and mitigation strategies for Bangkok. Inundation scenarios threaten the rice paddies of the Bangkok plain that contribute to Thailand's status as the number one global rice exporter. Other Asian mega-cities such as Jakarta and Ho Chi Minh City face similar inundation scenarios. One of the dramatic measures under consideration to protect Bangkok is the building of a dike between coastal resorts Hua Hin and Pattaya, with severe consequences for the tourism, fishing, shipping and other industries. The Bangkok Metropolitan Administration (BMA) is keen to have USG scientific and engineering collaboration, to formulate realistic assessments of what needs to be done. The eventual expansion of the USGS DRAGON program, as part of the Lower Mekong Initiative, to Bangkok and its Chao Praya River Delta would pay dividends. END SUMMARY AND COMMENT.

#### BANGKOK SUBSIDENCE HISTORY

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12. Bangkok lies in the Chao Praya River flood plain. After the recent release of several assessment reports, there has been renewed concern over severe flooding in Bangkok and surrounding rice farms from a combination of sea level rise and human-induced land subsidence. The Bangkok metropolitan area covers 7,761.50 square km, with an approximate population of 11,971,000 and has been pinpointed as a hotspot for a flooding disaster scenario by 2050 (as well as other large Delta mega cities in Southeast Asia like Ho Chi Minh City and Jakarta).

13. A long history of subsidence in Central Bangkok and surrounding suburbs has resulted in gradual sinking between 2cm and 5cm a year. Subsidence from deep well pumping has been acknowledged at least since the early 1980s. Much of the problem was caused by extraction of industrial water from underground aquifers faster than it could be replaced, causing the sandy soil of the aquifer to compress. The subsidence reached its most critical state in the early 1980s when it occurred at a rate as high as 120 mm/year.

14. Despite various attempts to regulate groundwater use, the subsidence-affected area has expanded in the last 20 years. Bangkok's city limits and water needs grew with increasing

population and development. Groundwater pumping (to meet these needs) from the thick aquifer system underneath the city has continued to increase from about 1.2 million cubic meters/day in the early 1980s to more than 2.0 million m<sup>3</sup>/day in 2000. Water levels in the main aquifer layers have been drawn down by as much as 65m. Data from the Asian Institute of Technology suggested that for one cubic meter of groundwater pumped out in the greater Bangkok Plain, approximately 0.10 m<sup>3</sup> of ground loss occurred at the surface. This would translate to about two feet of ground subsidence in the most affected areas.

15. With the added problems of rising sea levels, which the UN International Panel on Climate Change estimates at between 18cm and 59cm by 2050, and coastal erosion along the Gulf of Thailand, there are scenario estimates that Bangkok could soon be contending with regular flood waters up to 2 meters high. Salt water intrusion scenarios could also compromise drinking water aquifers as well as agricultural production. Present day estimations of infrastructure requirements and economic loss are calculated by academics and BMA at around US\$5 billion to "climate-proof" Bangkok.

#### BMA CLIMATE CHANGE MITIGATION ACTION PLAN

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16. Last month, ESTHoff and US Embassy Science Fellow met with Suwanna Jungrungruen, Director of Policy and Planning Division at the Bangkok Metropolitan Administration (BMA). (Note: BMA participated in WIREC (Washington International Renewable Energy Conference) in 2008. At WIREC, BMA pledged renewable energy actions, but most of the Thai BMA staffers who went to this meeting have moved to new positions. Renewable energy relates to Bangkok inundation scenarios in that BMA is encouraging clean and recyclable infrastructure as a way to mitigate climate change GHGs and curb water use. End Note). Thai research indicates that climate change, sea level rise, flooding and subsidence are creating future disaster scenarios for Bangkok similar to New Orleans.

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#### IDEAS FOR COLLABORATION

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17. ESTHoff asked BMA how the U.S. could best collaborate on issues associated with subsidence in Bangkok region, climate change, and flooding from both sea level rise and increased overland flow from river and intense precipitation events. BMA is most interested in collaboration associated with their Action Plan on Global Warming Mitigation based on 5 initiatives: 1-Expand Mass Transit & Improve Traffic system 2-Promote use of Renewable Energy(Biofuels) 3-Improve Building Electricity Consumption Efficiency 4-Improve Solid Waste Management & Wastewater Treatment Efficiency 5-Expand Park Area (plant more trees and increase open space to hold more water, absorb CO<sub>2</sub> and lower air temperatures). The goal of the Action Plan is to reduce emissions 15 percent by 2012 and to climate proof Bangkok. (Comment: This current action plan has little to deal with flooded infrastructure.)

18. Presently soil maps are not used as references for city planning. BMA is using diversions and holding ponds ("monkey cheeks") as flood water mitigation strategies on a small scale outside of central Bangkok. USDA expertise on soil mapping could help BMA plan its water infrastructure measures. BMA is interested in educating the public on green infrastructure; rooftop gardening; water consumption and runoff-cistern systems; recycling; and energy consumption. USG public education materials would be helpful. Making the link between research and policy choices is also needed. An international visitor program with multi-disciplinary participants could show BMA managers and scientists how the U.S. has dealt with similar issues in New Orleans and the Mississippi Delta. The USGS and USDA have experience in researching, managing and presenting to the legislature the issues associated with subsidence, flooding and sea level rise.

#### A DIKE ACROSS BAY OF THAILAND?

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19. On February 1, ESTHoff, Staff and US Embassy Science Fellow went to a well-attended presentation, "Is Bangkok Sinking?" that summarized Bangkok's subsidence history, the need for more research

on cause and effect scenarios with climate change in SE Asia coastal regions, the need for a regional approach for adaptation and mitigation strategies already considered to contend with conservative future flooding scenarios, education of the general population in Bangkok to fuel political will to address the problem proactively.

¶10. Dutch Professor Cor Dijkgraaf advocated a the building of a dike based on Netherland model designs in the Bay of Thailand to contain flood waters and protect the city from climate change sea level rise and storm or tsunami surges. Similar dike strategies are being considered in United States (New Orleans), South Korea, Vietnam, Indonesia and Bangladesh. Environmental consequences were mentioned as a concern but not addressed directly. Other technological concerns such as positive pumping of wastewater for treatment outside the city, mangrove reforestation to protect coastlines and technology to reverse subsidence and increase holding capacity in groundwater reserves were mentioned as interests by the audience but not directly addressed by the panel as viable long term strategies.

¶11. Comment: For Thailand, the proposed location of this dike could turn the northern portion of the Gulf of Thailand into a freshwater lake, encompassing the important tourist resorts of Hua Hin and Pattaya. Shrimp and other fisheries would be devastated and commercial shipping affected if not strangled. The billions of dollars price tag would significantly divert resources from other infrastructure priorities. BMA officials noted that the dike is only one scenario under consideration but other ideas are few. This is where the USGS expertise could play a significant role in educating the Thai how diking actions have had counterproductive effects in the U.S. New Orleans and the Mississippi Delta, with its extensive rice agriculture, are arguably more analogous to the Chao Praya Delta than it is to the Netherlands, upon which the diking plan is based. End Comment.

¶12. On February 3, ESTH officer and US Embassy Science Fellow met Dr. Anond Snidvongs (who led the Is Bangkok Sinking? Event), Director of the Southeast Asia START Regional Center (SEA-START) at Chulalongkorn University. SEA-START is one of eight regional

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centers of the Global Change System for Analysis, Research and Training (START) network, a joint project of the International Geosphere-Biosphere, International Human Dimension and World Climate Research Programmes. The START network has been actively working with APEC on 2010-2050 climate change scenarios. Anond explained that strategies to help Bangkok could adversely affect the important rice industries on the Bangkok plain. He asserted that interagency planning to safeguard the citizens and infrastructure of Bangkok while maintaining the various economic sectors is relatively underdeveloped. While Bangkok has a long history of dealing with flooding, the impending sea level rise challenges urban planning beyond the city's current ability to cope, he said.

#### COMING EVENTS

¶13. SEA-START and the East-West Center of Asian Pacific Network are co-organizing an international workshop entitled "Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities" August 23-September 1 in Bangkok to encourage locally led climate change risk and vulnerability assessment and its application to urban development and governance. SEA-START especially supports education for the general public on climate change issues and future impact scenarios to fuel political government-supported action. This workshop follows on a similar 2008 workshop. The APEC Center for Technology Foresight (based in Bangkok) also put on a workshop in 2008 for climate change dangers to Asian coastal mega-cities. The upcoming International Visitors Program on Liveable Cities, to which Post is sending a Thai participant, should provide good exposure to U.S plans for dealing with coastal cities.

#### NEXT STEPS AND RESEARCH NEEDS

¶14. Interlocutors told us that USG scientific expertise would be

helpful with respect to regional data collection and analysis for environmental impacts of climate change adaptation scenarios. There is interest in the USG sharing emerging technology on clean urban infrastructure, flood control strategies, waste water treatment facilities and forecasting mechanisms through regional associations as well as Bangkok Metropolitan Administration and other mega-city entities. Organizers of the SEA-START international workshop on Asian coastal cities' climate change vulnerability and risk assessment requested U.S. expert speakers. Expansion of the USGS DRAGON program to encompass Hanoi's Red and Bangkok's Chao Praya rivers would bring these vulnerable cities into the Lower Mekong Initiative environmental collaboration.

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